THE ROLE OF FOREIGN COMPARATIVE TESTING PROGRAMS IN ARMY MODERNIZATION

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This article illustrates how acquisition programs are adapting to a military industrial base that is undergoing reform-induced change. In search of the best suppliers for combat optical and sensing equipment, this program office successfully made use of foreign suppliers to develop and manufacture a new generation of equipment.

Being acutely aware that supremacy on the last battlefield in no way assures success on the next, the Army has embarked on a modernization program to ensure that it will continue to prevail in future conflicts. The formidable task of its implementation falls to the Army's acquisition managers, who must excel in what is undisputedly a hostile environment. Already shrinking limited resources, fierce competition from other programs, problems arising from issues on *"the other side of the interface"* to cover unanticipated developments require product managers to be vigilant, creative, and innovative.

Of late, a new feature has been added to the landscape to render the environment even more challenging — the mergers and acquisitions by and of the major defense contractors. This diminishes an already limited industrial base for key components and technologies essential to win in future hostilities. In the vanguard of this modernization effort is the second-generation forward looking infrared (PM FLIR), charged with ensuring that our forces will "own the night" in future conflicts.

As we equip the Army's premier warfighting platforms with an unparalleled day-and-night combat capability, the program manager (PM) FLIR is facing and successfully meeting these challenges. A key element of the acquisition strategy to improve the tank and infantry vehicle and scout sights includes foreign comparative testing programs. These effective efforts have allowed us to develop sources for the most critical components, obtain funding to qualify

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them, and ultimately award production contracts for two of the most technologically challenging components: the Standard Advanced Dewar Assembly II (SADA II — the "eye" of the FLIR, and its associated 1-W linear (OWL) drive cryogenic cooler.

MODERNIZATION

Without question, the U.S. Army demonstrated its preeminence in the sands of Desert Storm. But since that conflict with Iraq nearly a decade ago, the Army's missions have been increasing and expanding; the Army's leadership must ensure that the Army remains the most capable in the world, able to deter potential crises, and to respond to those that do arise. Only through a continuous commitment to the process of modernization can it be assured that its weapons will be appropriate for the next war. The underlying precept in the U.S. Army's modernization strategy is achieving information dominance while maintaining combat overmatch. Key among the platforms being modernized are those which fought so successfully in the Gulf War — the Abrams main battle tank and the Bradley infantry fighting vehicle.

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The modernization of the tank fleet is taking two paths. The first involves the "digitization" of some 1,550 M1A1s. The second, and the more notable, is the M1A2 system enhancement program (SEP), incorporating into a fleet of some 1,150 platforms a host of information dominance-enhancements — upgraded displays, digital maps, integrated global positioning system, embedded battle command, and overmatch sustaining improvements (an eye-safe laser rangefinder, armor upgrade, and an improved fire control capability). The most significant overmatch enhancement is the integration of a second-generation FLIR into both the commander's independent thermal viewer (CITV), and the gunner's primary sight (GPS). The second-generation FLIR will provide U.S. warfighters an unrivaled day, night, all-weather combat capability.

The other standout of the Gulf War, the Bradley infantry fighting vehicle, is also being modernized. Some 1,500 M2A2s will be configured as M2A2ODS-variants, while an additional 1,600 M2A3s will be modernized with embedded battle command and overmatch sustaining improvements: an eye-safe laser rangefinder, armor upgrade, and an improved ballistic fire control capability. A second-generation FLIR will be incorporated into both the improved Bradley acquisition subsystem (IBAS) and the commander's independent viewer (CIV) sights, providing the identical thermal imaging advantage as that of the Abrams SEP.

A third major beneficiary of second-generation FLIR technology are armor and infantry battalion scouts and the reconnaissance battalions in the interim brigade combat team, soon to be equipped with the long-range scout surveillance system (LRAS3). This reconnaissance and surveillance sensor will permit scouts to detect targets at ranges in excess of three times that of current system capability. LRAS3 utilizes the same SADA II

and OWL cooler integrated into the SEP tank and Bradley A3. This advanced thermal imaging capability and optical design will provide the scout with additional standoff capability, which will enable scouts to operate well outside of the range of threat direct fire weapons and sensors systems.

HTI/Second-Generation FLIR

The ultimate responsibility for the modernization of each weapon system resides, of course, with the respective platform project manager. Among the glaring deficiencies noted in the after-action reviews of Desert Storm was the inability of members of the combined arms team to see the same battlespace. In an effort to correct this, a Department of the Army Special Task Force[1] determined that there should be a single manager of Army FLIRs and that a common set of hardware should be developed and integrated horizontally across the fleet.

The Army's leadership embraced the study's recommendations, and the horizontal technology integration/second-generation FLIR (HTI/SGF) product office was established to develop and integrate a new common FLIR. The PM FLIR partners with the platform project managers in the execution of their modernization efforts.

The product manager of the second-generation FLIR has developed and is providing the common FLIR to an array of ground platforms. The SGF provides a significant overmatch as compared to adversary capabilities through improved sensitivity and resolution, resulting in greatly increased range performance. The HTI/SGF program satisfies operational requirements for the battlefield in 2000 and beyond for the Abrams SEP, the Bradley A3, the LRAS3, and the line-of-sight antitank (LOSAT) system.

Incorporating such features as dual fields of view, 30- and 60-Hz scan rates, 2x and 4x electronic zoom, and compatibility with the digitized battlefield, SGF offers an advantage in range of more than a factor of two greater than the first-generation common modules now equipping advanced nations' warfighting fleets. As such, it provides a leap ahead in battlefield capability, a capability that has been demonstrated during the field-testing of the Abrams, Bradley, and LRAS3 systems.[2, 3]

The FLIR consists of a common suite of hardware and software, designated the B-Kit, and sight-specific hardware and software (the A-Kit). The B-Kit comprises an electronics unit (EU) and components that integrate into a sensor unit. The EU includes an EMI filter, two power supplies, an interface control circuit card assembly (CCA), a video converter CCA, a video processor CCA, and a motherboard contained within a housing. The sensor unit includes a digitizer, cooler control, point-of-load regulator, and scanner control CCAs, along with a two-field of view afocal telescope, a scanner-imager assembly, and the "eye" of the system, the SADA II detector-Dewar-cooler assembly. It is this component that provides the

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leap-ahead operational capability, as well as, not surprisingly, the most significant technological challenges.

SADA II

Although it is functionally the FLIR's eye (because it in large measure defines the FLIR's performance), the SADA II detector-Dewar-cooler assembly is the virtual heart of SGF. The manufacture of a SADA II requires a demanding assortment of technologies — dealing with exotic materials, microelectronics, high vacuum, structure, and cryogenics.

The detector consists of an array of infrared radiation-sensitive material housed in a vacuum assembly, cryogenically cooled to –320 ºF. These microscopic diodes sense the infrared radiation differences across a scene arising from temperature and emissivity differences, convert them to electrical signals, process these signals, and output them to provide a two-dimensional rendering of the scene on a suitable display. The sensitivity and resolution of the detectors are such that even minute temperature differences are discernable in an image, which bears great similarity to a black and white TV picture. The performance is impressive, and is in stark contrast to the images generated by the first-generation common module FLIRs that equip the current fleets of combat vehicles and helicopters of today's arsenals.[2]

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The manufacture of this array (of 480 x 4 high-responsivity, low-noise diodes on a half-inch-long piece of material) and its hybridization to readout electronics presents enormous challenges. Despite scores of millions of dollars of investment during the engineering and manufacturing development (EMD) phase of the HTI program, there was but one qualified source for SADA II — a domestic one. Because of the critical role of the SADA II in the FLIR, there was a compelling impetus for the program to seek all possible means to obtain another SADA II vendor to reduce schedule and cost risk.

OWL

To achieve performance in the 8- to 12-µm band of the electromagnetic spectrum, the photosensitive detector material of the SADA II must be cooled to cryogenic temperatures. As with first-generation FLIRs, this is accomplished with a cooling engine. But unlike the rotary coolers used in the common module approach, a split-Stirling, 1-W cooling capacity, linear drive cooler cools the SADA II. The integrated design approach, with the cooler's regenerator integrated with the detector-dewar-cooler cold finger, places high demands on the manufacturing precision required, but permits a cooler of 50 percent less capacity, and therefore 50 percent less power demand on the system in which the FLIR is integrated. In addition, linear drive technology provides a four-to-tenfold increase in reliability and significant advantages in audible noise, vibration output, and cooldown

time. During the EMD phase of the program, only TI (now DRS Technologies), a domestic source, had successfully qualified.

FCT PROGRAM

The second-generation FLIR program had many technical risks and a complex management structure with which to contend. The program sought out innovative means to reduce costs and the exposure to limited sources of critical components. The product manager's need for alternative sources for the SADA II and the OWL cooler in order to drive down cost and to reduce program risk was both critical and urgent. As development efforts were domestically met with varying degrees of success, it made good sense to investigate potential foreign sources for these critical components. At issue was finding suitable offshore sources for the hardware, and obtaining the financial resources to qualify this hardware for use in the HTI/SGF program. For the former, the PM FLIR relied upon the expertise of its partners at CECOM's Night Vision and Electronics Directorate. For the latter, DoD's Foreign Comparative Testing (FCT) Program seemed tailor-made.

Congress established the FCT Program under Title 10 U.S. Code, Section 2350a and is promulgated in the DoD 5000.2 R. It has as its objectives improving our forces' warfighting capability, accelerating fielding of materiel to our troops, and saving taxpayer money. Through the test and evaluation of foreign nondevelopmental defense equipment, the program seeks to determine whether such equipment can satisfy military Service or Special Operations Command requirements or correct military mission area shortcomings. Annually, candidate projects are nominated through their respective Service components to the Office of the Under Secretary of Defense (Acquisition and Technology) and given priority. Key considerations in this process include strength of user advocacy, satisfaction of formal military requirements (operational requirements document, mission needs statement), potential for follow-on acquisitions, maturity of the end item, and identifiable advantages.

The Office of the Secretary of Defense (OSD) prioritized list is then submitted to Congress for approval. OSD provides funding for the congressionally approved programs to the Services to plan and conduct the tests and evaluations. The ultimate measure of the success of an FCT program resides in actual procurement of the components from the foreign source subsequent to the test and evaluation effort.

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SOFRADIR

An obvious offshore candidate for the SADA II was the French firm Societe' Francaise de Detecteurs Infrarouge (Sofradir). The FLIR/Night Vision and Electronic Sensors Directorate (NVESD) team had been following Sofradir's activities in this technology area with interest for some time. Some years before,

Sofradir had been selected to design and manufacture the original focal plane array for the LOSAT program. In addition, Sofradir was associated with a U.S. firm on production of the day-and-night thermal sight system, for which they provided a 288 x 4 focal plane array (comparable to the SADA II array). The company's expertise with mercury-cadmium-telluride photovoltaic technology, used in the SADA II, was clearly established. So it came as no surprise when Sofradir indicated interest in participating in the joint FLIR/NVESD FCT SADA II effort.

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Some modifications to the off-the-shelf Sofradir product were required to meet SADA II requirements, and because of its substantial experience in detector-dewar technology, this was assessed as low risk. The read-out electronic circuitry needed modification to accommodate a charged-couple device (CMOS) rather than a comlementary metal oxide semiconductor (CCD) approach. The command and control electronics (C&CE), normally provided by the host higher level assembly in European thermal imaging systems, had to be designed and fabricated.

In September 1995, Sofradir was awarded a FCT contract of almost $2 million for the procurement and associated qualification activities for nine SADA II units. Sofradir had selected U.S. firms to design and deliver the C&CE, and fabricate the read-out electronics.

Considerable interaction on technical details was required to ensure a total understanding of performance requirements and interfaces. Language, distance, and issues relating to security classification of the SADA II components further complicated the process. But the challenges were overcome, and delivery of units began in May 1997. Qualification testing (including performance, nuclear, and environmental tests, plus a 4,000-hour reliability test) was conducted by NVESD, and ultimately the design was demonstrated to meet the specification requirements.

Mindful of future procurements projected by the FLIR product manager, Sofradir, relying heavily on their 288 x 4 production and motivated by their desire to be a worldwide supplier, made a commitment to stay competitive in the SADA II market. They looked to French firms for the new C&CEs and readout chips. The PM FLIR, recognizing the merits of maintaining a competitive environment and the quality of the Sofradir SADA IIs, awarded a $500,000 contract in August 1998 for seven additional SADA IIs with the redesigned components to validate the design and to use in special projects.

In January 1999, PM FLIR competitively awarded contracts for SADA IIs in support of B-Kit full-rate production. Sofradir won a $3.5 million production contract for approximately 20 percent of the SADA II requirement. This contract marked the culmination of years of effort on the part of both the U.S. government and Sofradir. The competitive pressures deriving from Sofradir's participation in the SADA II market via the FCT program had a dramatic effect in promoting efficiencies in domestic vendors which was directly reflected in dramatic price reductions.

AIM

At the same time that offshore vendors for SADA II were being sought, the PM FLIR/NVESD team was pursuing a parallel search for prospective producers of the OWL cooler. Domestically, TI (DRS Technologies) had qualified its OWL cooler, with BEI working toward developing a specification-compliant cooler. One of the two vendors that responded to the worldwide market survey for the OWL cooler was AEG (later AEG Infrared Modules, or AIM) of Germany.

Again, as in the case of SADA II, slight modification to AIM's existing cooler configuration would be required to meet the OWL cooler specification and drawings, but this was assessed as low risk. In March 1996, a contract under a joint PM FLIR/NVESD FCT program in the amount of $166,000 was awarded to AIM for the delivery and testing of 12 OWL coolers to be used to support qualification testing.

Following technical interactions between U.S. Government and AIM engineers, the cooler design was appropriately modified and deliveries of units were made. Qualification testing was conducted both at NVESD and AIM and progressed with few issues. AIM OWL coolers were integrated into SADA IIs from the three producers to demonstrate interchangeability. The close coordination between AIM and NVESD engineers helped to assure success.

During the course of the qualification testing, PM FLIR solicited for OWL coolers to support the second-generation FLIR B-Kit Low Rate Initial Production (LRIP) SADA II procurement, the OWL cooler to be provided as government-furnished material (GFM) to SADA vendors. In April of 1997, with all but the final phase of life testing completed, PM FLIR awarded a $1.3-million, 1-year contract (with an option year) to AIM. This amounted to 139 units delivered under this contract. In June of 1997 qualification testing was successfully completed, well in advance of first deliveries.

In late 1998, PM FLIR again solicited to procure OWL coolers to support the first production year of B-Kits; the OWL cooler to be furnished as GFM to SADA II vendors. And once again, AIM's proposal won them the 30 percent share — 139 units at $1 million, plus options. Deliveries are currently under way. By any measure, the FCT program with AIM for OWL coolers is a categorical success, with product qualification and two production contracts stemming from the effort. It should be noted too that as of this writing, DRS and AIM are the only two qualified vendors for OWL coolers. Without this FCT program, PM FLIR would have been captive to a sole-source environment; with it, the forces of competition have driven down cooler costs and reduced programmatic risk.

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CONCLUSION

The Army remains committed to maintaining its supremacy on future battlefields. To do so means that it must continue to modernize. The Army's principal warfighting platforms are being upgraded

or enhanced with systems and components to win the information war and to maintain combat overmatch. The second-generation FLIR is critical in this process, giving our forces an unequalled day, night, and all-weather capability to detect, recognize, and identify their enemy. The most critical components of the B-Kit, the SADA II and the OWL cooler, constitute daunting technological challenges. PM FLIR and NVESD have been successful in leveraging FCT programs to meet those challenges. The result is a wider field of qualified vendors and the concomitant benefits of market competition — diminished program risk and reduced component prices. The ultimate beneficiaries are the soldiers whose success in the next conflict will be determined by the effectiveness of the equipment provided to them.

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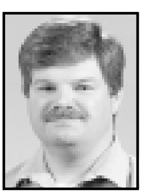

Raef Schmidt is currently the deputy product manager for FLIR within the U.S. Army's PM-NV/RSTA office. He has been a member of the technical staff at PM-FLIR for six years and has 16 years of experience in the development and acquisition of Army materiel. Schmidt has an M.S. degree in mechanical engineering from Catholic University and a B.S. degree in mechanical engineering from Michigan Technological University.

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ENDNOTES

1. Second-Generation FLIR Special Task Force, established February 8, 1993, by the Army Acquisition Executive.

2. Detect, acquire, recognize, identify (DARI) testing, November 1998.

3. Abrams follow-on test and evaluation, June 1999.

REFERENCE

Cooperative Research and Development Projects: Allied Countries, 10 U.S.C. § 2350a and is promulgated in the DoD 5000.2-R.